

National Aeronautics and
Space Administration

Educator Product

Educators

Grades 5-8

EG-2004-10-501-ARC

Future Flight Design

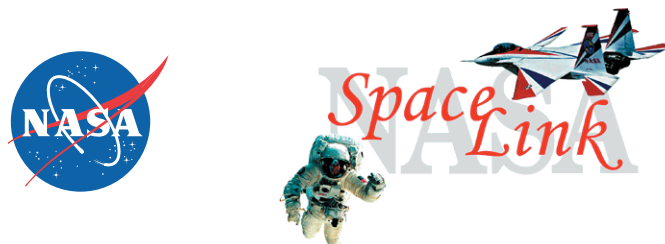
Part I



Educator and Student Guides

Air Transportation Problem

[http:// futureflight.arc.nasa.gov](http://futureflight.arc.nasa.gov)



Future Flight Design Educator Guides

are available in electronic format through NASA Spacelink—one of NASA's electronic resources specifically developed for the educational community.

This publication and other educational products may be accessed at the following address:

<http://spacelink.nasa.gov/products>



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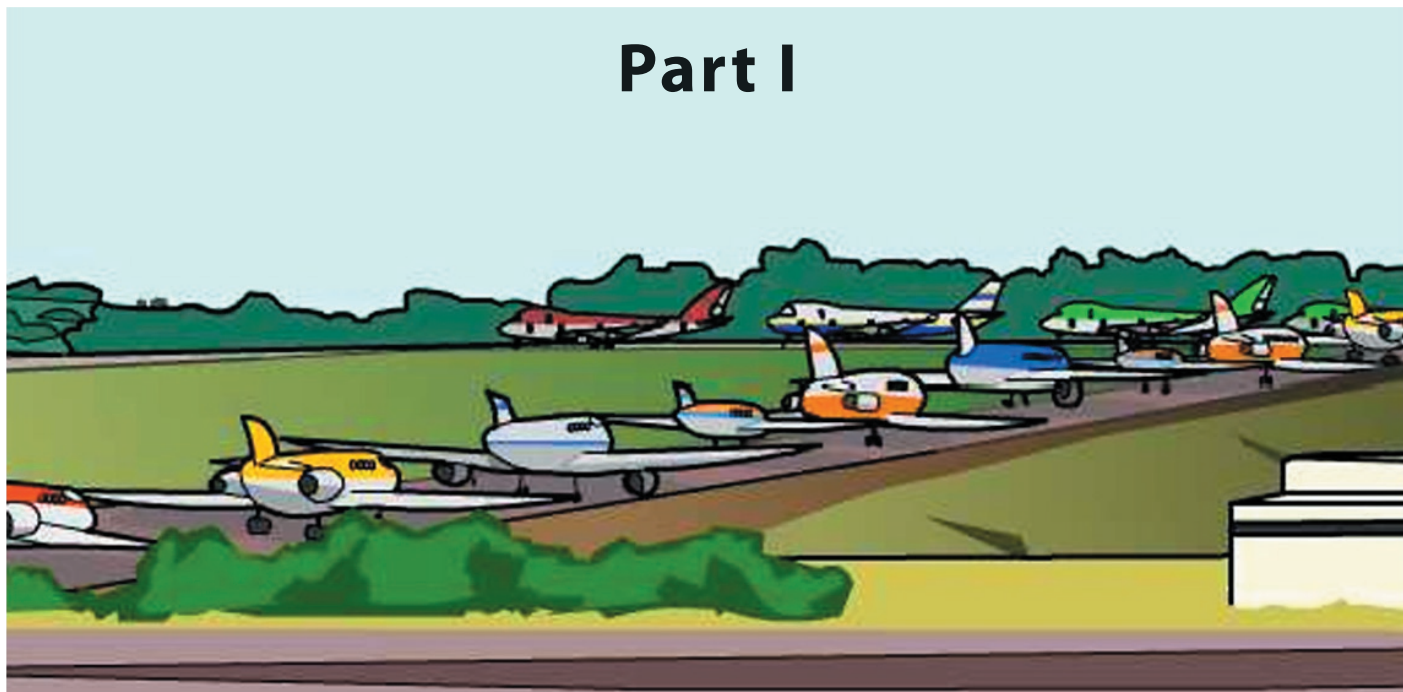
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Future Flight Design

Part I



AIR TRANSPORTATION PROBLEM

INTRODUCTION

The Future Flight Design Air Transportation Problem Educator Guide has been developed by the National Aeronautics and Space Administration (NASA) for the purpose of increasing students' awareness of and interest in aeronautics, aviation and the many career opportunities that utilize science, math, and technology skills. The lessons are designed for educators to use with students in grades 5–8 in conjunction with the Future Flight Design multimedia activities on the Future Flight Design Web site (<http://futureflight.arc.nasa.gov>).

F

Future Flight Design Overview

Future Flight Design is a web-based interactive, problem-based learning environment where students in grades 5–8 learn about forces of flight and design air transportation and aircraft systems of the future. Biographies highlight careers in aeronautics and aerospace engineering.



F Future Flight Design Overall Goal

Future Flight Design uses aeronautics and aviation content, problem-based learning, the engineering design process, and critical thinking skills to increase awareness of NASA careers and to educate students in grades 5-8 on the design of capacity solutions for a future air transportation system.

F Future Flight Design Part I Overall Objectives

- Students in grades 5-8 will use problem-based learning to research and propose solutions for an improved air transportation system.
- Students will identify at least one NASA occupation that best fits their interests and skills.

F Future Flight Design Structure

Future Flight Design is composed of two problems: Air Transportation Problem and Aircraft Design Problem. The Introduction Movie presents the overall problem of increasing airport delays due to an increasing demand on the current system. This movie provides the overall purpose and motivation for the two problems. Each problem includes an Educator Guide, Student Log and online resources. The Air Transportation Problem includes numerous movie clips and online articles to assist students in researching solutions to the problem. The Aircraft Design Problem includes interactive multimedia activities in which students simulate the design and testing of a new aircraft while exploring instructional animations in the online labs to better understand the results of their design choices. Occasional live, online challenges on NASA Quest, will allow students the opportunity to connect with and receive feedback from NASA engineers working on the same problems.

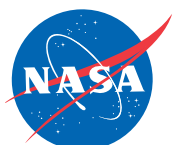
PART I

Future Flight Design: Air Transportation Problem

In the Air Transportation Problem, students select roles and follow the problem-based learning process to design an improved air transportation system. This problem-based learning process is as follows:

- Step 1: Letter from NASA
- Step 2: Get a Team Together
- Step 3: Discuss the Air Transportation Problem
- Step 4: Select a Role
- Step 5: Write Down What You Need to Know
- Step 6: Find the Answers to Your Questions
- Step 7: Discuss Your Solutions
- Step 8: Create a Presentation
- Step 9: Present the Results

As they go through this process making use of online resources, they learn about current issues in the air transportation system, air traffic management, airport and flight planning, the hub and spoke system, trade-offs. They also gain an awareness of numerous science, engineering, and technology careers. The problem concludes with students presenting their solutions before an Air Transportation Committee for evaluation.





Information Resources

NASA's Airspace Systems Program is described at the following web site: <http://www.asc.nasa.gov/>

For Educators Grades 5-8:

Title	Link	Description	Type
Exploring the Extreme	http://spacelink.nasa.gov/	This guide presents the basic science of aeronautics by emphasizing hands-on involvement, prediction, data collections and interpretation, teamwork, and problem solving.	Educator guide
Adventures in Aeronautics	http://avst.larc.nasa.gov/education.html	A storybook that teaches all about aeronautics at NASA. Available in English, Spanish and Chinese. A coloring book is also available	Storybook and Coloring book
Exploring Aeronautics	http://core.nasa.gov/	This CD-ROM offers an introduction to aeronautics, covers the fundamentals of flight, contains a historical timeline, examines different types of aircraft and teaches students to use the tools of aeronautics used by researchers to test aircraft designs.	CD-ROM
Fold It and Fly It!	http://www.nasaexplores.com/	This activity demonstrates how an assembly line works, in the context of building aircraft.	Hands-on activity
Fractal Ownership	http://www.nasaexplores.com/	This activity teaches students how to use mathematics skills to solve fractions, in the context of owning your own jet.	Hands-on activity
Small Jets, Big Future	http://www.nasaexplores.com/	NASAExplores provides science articles about NASA programs written at various age levels. This article describes the future of personal aircraft. Supplemental activities are included.	Science article with supplemental activities
X-1 Paper Glider kit	http://spacelink.nasa.gov/	This NASA Educational Brief, featuring the X-1, investigates the basics of flight with a paper model of the first supersonic aircraft.	Paper model kit
Learning to Fly: the Wright Brother's Adventure	http://spacelink.nasa.gov/	This NASA educator guide has excellent background information about Wilbur and Orville Wright. The guide contains student activity pages and templates for building the 1900, 1901, and 1902 Gliders and the 1903 Flyer.	Educator guide

For direct links to these and dozens of other educator resources for K-12, please visit:

<http://futureflight.arc.nasa.gov/resources.html>



Education Standards

In addition to meeting the National Science Education Standards, International Technology Education Association and International Society for Technology in Education standards, Future Flight Design Educator Guides are written to meet benchmarks found in the Benchmarks for Science Literacy produced by the American Association for the Advancement of Science (AAAS) as part of their science, math, and technology reform movement called Project 2061. The mission of Project 2061 is to “shape the future of education in America, a future in which all students [will] become literate in science, mathematics and technology by graduation from high school” (p.VII).¹ “The Benchmarks for Science Literacy are statements of what all students should know or be able to do in science, mathematics and technology by the end of grades 2, 5, 8 and 12” (p.XI)² and are based on extensive research of when and how it is developmentally appropriate to teach the concepts and skills described.

The tables below show the benchmarks and standards for the Air Transportation Problem. The first portion of the table entry identifies which standards or benchmarks are referenced. “2061” is a reference to the Benchmarks for Science Literacy. “NSES” is a reference to the National Science Education Standards. “ITEA” is a reference to the International Technology Education Association national education standards. “ISTE” is a reference to the International Society for Technology in Education standards. The second portion of the table entry identifies the specific standard referenced. In the case of Project 2061, the standard is referenced, the grade range and then the number of the concept under this standard and grade range. We distinguish between “meeting” benchmarks or standards, “partially meeting” them and “addressing” them to alert educators to concepts that are taught or partially taught for deep understanding in a lesson compared to topics or ideas that we might touch upon but do not really teach for deep understanding.

A

Air Transportation Problem Objectives/Standards

Objectives	Standards
<ul style="list-style-type: none"> Students will create a list of current issues/problems in the Air Transportation System. Students will choose roles and create a list of questions to research the growing need for increased capacity in our Air Transportation System. Students will gather and analyze information to answer their questions that will help them design a solution to the Air Transportation Problem. Students will work as a team to share their research and brainstorm solutions to the capacity problem in the Air Transportation System. Students will create a list of trade-offs associated with each of their solutions. Students will create and give a poster or software created presentation that describes one or more solutions to the capacity problem in the Air Transportation System, their associated trade-offs, and is based on factual information gathered from their research. 	<p>Meets:</p> <p>NSES E (5-8) #2, 4, 5</p> <p>2061 3B (3-5) #1</p> <p>2061 12E (3-5) #1</p> <p>2061 3B (6-8) #1</p> <p>Partially Meets:</p> <p>ISTE 1</p> <p>2061 1C (3-5) #2</p> <p>2061 3A (3-5) #4</p> <p>2061 12D (3-5) #2</p> <p>2061 12D (6-8) #3</p> <p>Addresses:</p> <p>ITEA #10, 18</p>



More information on the benchmarks and standards referenced can be found at the following Web addresses:

Standard/Benchmark Title	Web Address
American Association for the Advancement of Science: Project 2061	http://www.project2061.org/
National Science Education Standards (NSES)	http://www.nap.edu/readingroom/books/nses/html/
National Council of Teachers on Mathematics (NCTM)	http://standards.nctm.org/index.htm
International Society for Technology in Education (ISTE)	http://cnets.iste.org/
International Technology Education Association (ITEA)	http://www.iteawww.org/TAA/TAA.html

¹ Project 2061, American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York. Oxford University Press. (p. VII).

² Project 2061. (p. XI).

Overview of Problem-Based Learning (PBL)

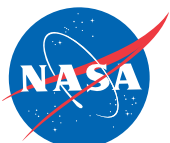
W What is PBL?

PBL is an approach to curriculum development and instruction. It simultaneously develops problem solving strategies, disciplinary knowledge bases, and skills by placing students in the active role of problem-solvers confronted with an ill-structured problem that mirrors real-world problems.

Problem-based learning has as its organizing center the ill-structured problem that:

1. Is messy and complex in nature.
2. Requires inquiry, information-gathering, and reflection.
3. Is changing and tentative.
4. Has no simple, fixed, formulaic, "right" solution.

Problem-based learning begins with the introduction of an ill-structured problem on which all learning centers. Teachers assume the role of cognitive and metacognitive coach rather than knowledge-holder and disseminator; students assume the role of active problem-solvers, decision-makers, and meaning-makers rather than passive listeners.



Examples:

You are a scientist at the state department of nuclear safety. Some people in a small community feel their health is at risk because a company keeps thorium piled above ground at one of their plants. What action, if any, should be taken?

You are a consultant to the Department of Fish and Wildlife. A first draft of a plan for the reintroduction of wolves to Yellowstone has received strong, negative testimony at hearings. What is your advice regarding the plan?

You are a thirty-six year old single working mother with a five year old daughter. Upon your husband's death, you receive \$20,000 in worker's compensation and \$10,000 in stock option shares. How can you invest this money so that by your daughter's 18th birthday, its growth is maximized?

W

What Are The Benefits of PBL?

PBL promotes:

Motivation

PBL makes students more engaged in learning because they are hard-wired to respond to dissonance and because they feel they are empowered to have an impact on the outcome of the investigation.

Relevance and Context

PBL offers students an obvious answer to the questions, "Why do we need to learn this information?" and "What does what I am doing in school have to do with anything in the real world?"

Higher-Order Thinking

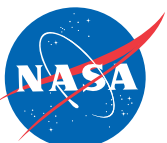
The ill-structured problem scenario calls forth critical and creative thinking by suspending the guessing game of, "What's the right answer the teacher wants me to find?"

Learning How to Learn

PBL promotes metacognition and self-regulated learning by asking students to generate their own strategies for problem definition, information gathering, data-analysis, and hypothesis-building and testing, and comparing these strategies against and sharing them with other students' and mentors' strategies.

Authenticity

PBL engages students in learning information in ways that are similar to the ways in which it will be recalled and employed in future situations and assesses learning in ways which demonstrate understanding and not mere acquisition. (Gick and Holyoak, 1983).



A **Aligning PBL Instruction and Assessment**

Suggestion One

Stress that students are professionals in the field in which the ill-structured problem exists and assess them as if you were their supervisor.

One of the greatest challenges to teachers is to keep their students motivated and engaged in classroom activities. Having students operate as professionals in the field in which the ill-structured problem arises increases student enthusiasm and ownership for learning. For instance, if studying a unit on solar home design, the students could play the role of architects. As part of the role-playing, teachers acting as facilitators and real-world supervisors hold positions that make assessment both appropriate and realistic. Also in this context, the activity is no longer unrelated to anything outside of the classroom. Students in this scenario can now see that their efforts relate to issues that society has faced or is facing.

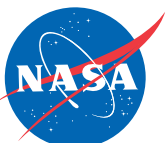
Suggestion Two

If instruction is problem-based, assessment should be similarly structured.

If students are asked in the course of a unit to solve ill-structured problems through hands-on activities, the assessment should include how well they complete that task. That is not to say an evaluation of their ability to learn factual and foundational information important to solving the problem should not be completed. Rather, an interdisciplinary, real world and hands-on approach to learning should be evaluated largely in the same manner it is taught. To have students design and build a model of a better solar home and then have the assessment be based solely on a true and false, multiple choice test undermines the creative process and sends mixed messages to students about the importance of the PBL activity. The instructor should instead act as a building inspector and qualitatively and quantitatively evaluate the students' work.

Suggestion Three

Provide reasonable guidelines regarding your expectations for the students. A single path to the solution of a real world ill-structured problem rarely exists, whether it relates to what scientists face in the laboratory or professionals encounter in the field. Teachers engaged in PBL should present student expectations before the unit begins so the students will understand their goals and how their progress will be assessed. Of course, ridiculously detailed goals and solution criteria are antithetical to PBL, so expectations should be flexible enough to allow for student exploration. Providing students with this allowance for creativity while maintaining a realistic timeline fosters growth and inventiveness that is not easily achieved within a cookbook lab or worksheet-based curriculum. For example, in the case of designing a better solar home, create a list of open-ended goals or "building code specifications" with the students at the beginning of the PBL activity.



Suggestion Four

Don't hold off on assessment until the end of the activity or unit; model real-world behavior, in which ongoing assessment occurs.

In traditional classroom teaching, assessment of student learning is often relegated to the end of a given unit. This assessment tends to stress student recollection of factual knowledge, in direct opposition to current beliefs that significant amounts of learning take place during the process of solving a problem. The emphasis on the use of factual knowledge in conjunction with real world problem solving skills makes PBL an advantageous approach to teaching and assessment. Instructors need to assess students continuously during the course of their problem solving, much as real-world supervisors would oversee a project. For instance, the instructor as building inspector is free to examine how well the students address the established goals while also having the freedom to suggest modifications or give approval on student developments. This role allows the teacher to act as a facilitator, asking guiding questions that allow students to approach a solution or solutions to the problem at hand.

Suggested Lesson

M Materials

- 1 Capacity Problem Student Log for each student
- 1 computer with Internet access connected to projector or TV screen for whole class viewing (optional)
- 1 computer or more for each group of 2-5 students
- Poster paper and markers or computers with presentation software for each group
- Extra copies of Evaluation Rubric for committee members
- Student certificates located in the Teachers Section

P Preparation

- Download, print, and photocopy Capacity Problem Student Logs at: http://futureflight.arc.nasa.gov/pdf/ffd_pbl_student.pdf
- Download, print, and photocopy student certificates at: <http://futureflight.arc.nasa.gov/teacher.html>
- All computers must have an Internet connection with browser, and Flash plug-ins. This plug-in can be downloaded free from Macromedia Software at: <http://www.macromedia.com/downloads/>
- Be sure to test computers a day or two ahead of time. If you can view the Introduction Movie, they computer will be able to support the rest of the Web site.
- Assign student groups (2-5 students) ahead of time if desired.
- Invite community members such as parents, airport personnel, staff or administrators with free periods, etc. to become a "committee member" and help evaluate student presentations on Day 4. Suggested roles: senior airport planner, local resident, environmentalist, investor. This will make the PBL more authentic and motivate the students to do a good job!



S Suggested Schedule

Day 1	Day 2	Day 3	Day 4
Introduction Step 1: Letter from NASA Step 2: Get a Team Together Step 3: Discuss the Air Transportation Problem Step 4: Select a Role Step 5: Write Down What You Need to Know	Step 6: Find the Answers to Your Questions	Step 7: Discuss Your Solutions Step 8: Create a Presentation	Step 9: Present the Results



Day 1 (45 – 60 minutes)

Teacher Tip: Student computers are not required for the first day of instruction. Day 1 can be completed with a single computer with Internet access projected to a large screen or TV.

Introduction (5 Minutes)

Procedure

- Pass out student logs and read the Introduction as a class.
- Use computer/projector system to watch Introduction Movie as a whole class.
- Allow students to share related personal stories of air travel.

Define the Air Transportation Problem (15 Minutes)

Step 1: Letter from NASA

- Read the Letter from NASA on Web site. A copy is also provided in the Student Log.
- Explain that the next step will be to form a Research Team.

Step 2: Get a Team Together

- Teams can be anywhere from 2-5 students.
- Allow students to form teams or assign teams you have already formed.
- Have students gather in their teams and enter each team member's name in their Student Logs.



Step 3: Discuss the Air Transportation Problem

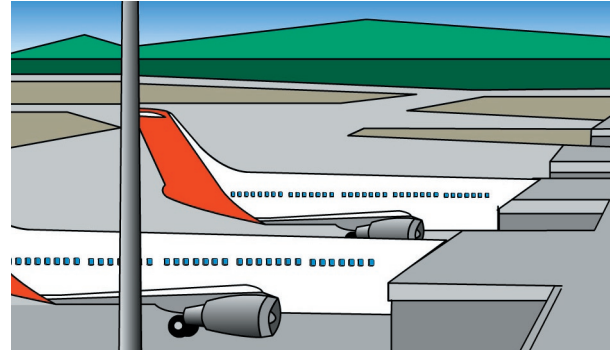
- In their groups, have students read the Background Information quietly to each other.
- Allow students 5-10 minutes to discuss and write down their list of problems with air travel today.



Team and Roles (10 Minutes)

Step 4: Select a Role

- Explain that each team member is going to role-play a profession related to the air transportation system as they work to solve the problem.
- Allow 5-10 minutes for students to read the biographies and select roles. These are listed both on the Web site and in the Student Log.
- Have students write their new titles next to each team member's name already listed in their Student Logs.



What You Need to Know (15 Minutes)

Step 5: Write Down What You Need to Know

- At this point, the students should understand the "problem" in this Problem Based Learning scenario: How can our air transportation system handle the large increase in people and cargo that will take place over the next 20 years?
- This step is asking students to do two things: 1) Ask questions that will help them look for solutions to the main problem and 2) Assign questions to each team member that "fit" their chosen roles.
- Collect each student's list of questions before beginning Day 2 of the lesson. This will allow you to review each student's list to check for understanding and to make sure they have selected appropriate questions for research.



Day 2 (45 – 60 minutes)

Teacher Tip: Each team of students will need one or more computers to complete the research step of the PBL. Alternatively, you can download and print out the articles for students to read offline while others take turns watching the videos and animations online.

Research

Step 6: Find the Answers to Your Questions

- Return student questions and have each group assemble at their computer station(s). Review the instructions in the Student Log for Step 6.
- Direct students to <http://futureflight.arc.nasa.gov>
- Students will click on the aircraft and end at the Welcome Screen. Students have the option to watch the Introduction Movie again, or to go directly to the Air Transportation Problem.
- Students will see the NASA Letter and should scroll down to the instructions. Here they can either review the role they have chosen or click on the Research link.
- The Research area contains links to all of the articles and videos available to students. Instruct students to navigate through this section to find the answers to their questions. Encourage students to take notes and write down new questions, or ideas. Some students may find new information that leads them in an unexpected, but interesting area of research. Encourage exploration!

Day 3 (45 – 60 minutes)

Teacher Tip: If students have completed their research and are using poster paper and markers for their presentations, multiple computers are not required to complete Day 3. Otherwise students will need access to computers with presentation software to complete their presentations.

Present the Results

Step 7: Discuss Your Solutions

- Each team will now come together and discuss their research. Have students read the directions for Step 7 in the Student Log.
- Once each team member has had a chance to contribute, the team should begin brainstorming solutions to the air transportation problem: How can our air transportation system to handle the large increase in people and cargo that will take place over the next 20 years?
- Encourage students to be creative as they plan for the air transportation system of the future. Remind students of the following:
 - Each team will make a presentation before an Air Transportation Committee who will evaluate their work.
 - Any solution is possible, but check to make sure that its environmentally friendly, isn't too noisy, and is backed up by facts from the research. Be innovative!



Step 8: Create a Presentation

- a. Once students have discussed all their ideas, they must organize their work into a presentation before an Air Transportation Committee. Designate a time limit for each presentation.
- b. Review the Evaluation Rubric provided in the Student Log with the students. (Page 12 of Student Log)
- c. Once students have completed their presentation, have them complete and turn in an "Abstract" that will act as a cover sheet for their evaluation. (Page 13 of Student Log)

Your poster or presentation will be evaluated using the following rubric:

4	<ul style="list-style-type: none">• The poster/presentation clearly and accurately describes two or more solutions, how it solves the air transportation problem, addresses trade-offs for each solution, and is backed up with facts from research.• The poster/presentation is creative and persuasive and has accurate and clear descriptions and illustrations that match the solution and make it easy to understand.
3	<ul style="list-style-type: none">• The poster/presentation clearly and accurately describes one or more solutions, how it solves the air transportation problem, addresses at least one trade off, and is backed up with facts from research.• The poster/presentation is persuasive and has clear descriptions and illustrations that match the solutions.
2	<ul style="list-style-type: none">• The poster/presentation is not completely clear or accurate in describing a solution, how it solves the air transportation problem and may be missing trade-offs for each solution, or is not backed up with facts from research.• The poster/presentation lacks organization. Illustrations or descriptions are a difficult to read or do not match the solutions.
1	<ul style="list-style-type: none">• The poster/presentation is not clear or accurate in describing a solution, how it how it solves the air transportation problem, is missing trade-offs for each solution, and is not backed up with facts from research.• The poster/presentation is incomplete, lacks organization, readability, or does not contain illustrations or descriptions



Day 4 (45 – 60 minutes)

Step 9: Present the Results

- Seat Air Transportation Committee members at a table and provide each with a copy of the rubric and the presentation abstracts for each group.
- Introduce each committee member and begin presentations. Allow for committee members to comment or ask questions as time permits.
- At the conclusion of all the presentations, you may want committee members to make some general comments to the group as a whole and assist in presenting certificates to each student by team.

Possible Solutions to the Air Transportation Problem

Teacher Tip: This is just a handful of possibilities students may devise. Encourage students to be both innovative and research-based!

N New Aircraft Design

- Design larger airplanes, or design new aircraft that require a shorter distance for take-off and landing. This would lead to shorter lines on the runway because the airplanes would take off and land more quickly. Students may investigate what it would take to shorten the landing distance. Consider the use of a hybrid of an airplane and rotorcraft, since rotorcraft take off and land vertically.
- Develop new aircraft that do not require a pilot or co-pilot. For example, many trains (such as a tram or subway) and most cargo ships do not require a pilot for navigation. A pilot would be on the plane in case something went wrong. A co-pilot would not be required.

A Airports

- Use existing small airports for short flights. Use existing large airports for large aircraft that will take many passengers for long distances. Build more airports.
- Streamline operations at existing airports. Change airplane routes, possibly expanding the altitudes in which they can fly. Develop a system that would require fewer stops. Change the hub and spoke model to something that works better like using local and regional airports for short- and medium-distance travel.
- Have airplanes fly more times of the day (like in the middle of the night).

A Automation

- Develop computer programs that will automatically reroute aircraft when the weather is bad, taking into consideration all the other aircraft in the area.
- Design software that can take over mundane or complex tasks for air traffic controllers so they don't get bored, tired, or stressed out.

H Human Factors

- Design the controls on an aircraft so that they are not too complicated to use.



Educational Standards List

Benchmarks for Science Literacy (2061)

1. The Nature of Science

C. The Scientific Enterprise, Grades 3-5

#2 Clear communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.

3. The Nature of Technology

A. Technology and Science, Grades 3-5

#4 Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, senses, and minds. The changes may be for survival needs such as food, shelter, and defense, for communication and transportation, or to gain knowledge and express ideas.

B. Design and Systems, Grades 3-5

#1 There is no perfect design. Designs that are best in one respect (safety or ease of use, for example) may be inferior in other ways (cost or appearance). Usually some features must be sacrificed to get others. How such trade-offs are received depends upon which features are emphasized and which are down-played.

B. Design and Systems Grades 6-8

#1 Design usually requires taking constraints into account. Some constraints, such as gravity or the properties of the materials to be used, are unavoidable. Other constraints, including economic, political, social, ethical, and aesthetic ones, limit choices.

12. Habits of Mind

D. Communication Skills, Grades 3-5

#2 Make sketches to aid in explaining procedures or ideas.

D. Communication Skills, Grades 6-8

#3 Locate information in reference books, back issues of newspapers and magazines, compact disks, and computer databases.

E. Critical-Response Skills, Grades 3-5

#1 Buttress their statements with facts found in books, articles, and databases, and identify the sources used and expect others to do the same.

International Technology Education Association (ITEA)

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving

The Designed World, Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.



International Society for Technology in Education (ISTE)

Technology Problem-Solving and Decision-Making Tools

#1 Students use technology resources for solving problems and making informed decisions.

National Science Education Standards (NSES)

E. Science and Technology,

Grades 5-8 Understandings About Science and Technology

#4 Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Engineers often build in back-up systems to provide safety. Risk is part of living in a highly technological world. Reducing risk often results in new technology

#5 Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials, or effects of weather and friction; other constraints limit choices in the design, for example, environmental protection, human safety, and aesthetics.

Grades 5-8 Abilities of Technological Design

#2 Design a solution or product. Students should make and compare different proposals in the light of the criteria they have selected. They must consider constraints—such as cost, time, trade-offs, and materials needed—and communicate ideas with drawings and simple models.

